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FIELD OF INVENTION:

This invention relates to an olefin polymerisation titanium catalyst, a process for the preparation thereof and a process for the polymerisation of an olefin employing the catalyst.

PRIOR ART:

Polymers of olefins especially lower olefins or α-alkenes such as ethylene, propylene or 1-butene are important materials because of their substantial commercial use in the manufacture of a variety of articles including plastic bags, sheets or automobile parts. The polymerisation of these alkenes has been widely practised for decades and involves the reaction of lower α-alkene such as ethylene with a catalyst under polymerisation conditions.

In commercial lower α-alkene polymerisation, solid heterogeneous catalysts comprising magnesium dichloride supported titanium catalysts are predominantly used. One method for preparation of these catalysts comprises halogenation of an organo magnesium compound like magnesium alkoxide with or without titanium followed by treatment with titanium compound like titanium teterachloride. A second method for preparation of these catalysts involves reaction of magnesium dichloride and a titanium compound (US patents nos 4329253, 4393182, 4400302, 4414132, 4535068, 4330649, 4472521, 4540679, 4728705, 4710428, 5106806, 5122494 and 5281567). In the first method the halogenating agent usually used is titanium tetrachloride itself. Therefore, this method consumes considerably large amount of titanium tetrachloride based on the final titanium content in the catalysts and is not economical. Another disadvantage

of use of organomagnesium compound like magnesium alkoxide is that during the catalyst synthesis species other than titanium tetrachloride is produced. For propylene polymerisation, this necessitates further treatment of the catalyst with a halogenating agent to achieve a desirable level of catalytic activity. Here again, the use of excess halogenating agent is not economical. In the second method special techniques like ball milling are used. Therefore, the catalyst formed is a physical mixture of titanium and magnesium compounds where the bonding between the particles may not be good thereby adversely affecting the catalytic activity. While these disadvantages may be overcome by using activated anhydrous magnesium dichloride as starting material, in order to obtain catalysts of optimum particles size or morphology, additional preparative steps such as spray drying or melting are required, which make the process time consuming, inconvenient, and uneconomical. US Patent No 4900706 discloses a catalyst comprising titanium, magnesium and chlorine deposited on an organic polymer support like styrene-divinyl benzene copolymer. However, in this case also because of the use of an organomagnesium precursor, a final treatment with titanium tetrachloride is required to give a catalytically active component.

Various organic polymers have been used as support material for titanium or vanadium halide and aluminium alkyl based polymerisation catalysts. In USSR Author's Certificate No 682262 and Application No 2187995/23-04 being supplement thereto, non-metallocene catalysts based on titanium halides supported on polyethylene or polypropylene particles having substantially inert surfaces or copolymer of ethylene and vinyl alcohol having active surface hydroxyl groups are

described . Both these support materials have been reported to show low activity or easy leaching of the catalyst. USSR Application No 1886351/23-04 describes use of homopolymers of styrene and copolymers thereof with divinyl benzene as support for vanadium or titanium tetrahalide. The aromatic rings of the organic polymer are believed to reduce vanadium/titanium tetrahalide to a solid phase of the corresponding trihalide which remains trapped within the pores and on the surface of the support to provide an active catalyst. These supports are not suitable for use in the case of titanium and/or vanadium alkoxides and / or halo alkoxides. These compounds are reported to be active ethylene polymerisation catalysts (S M Pillai, M Ravindranathan and S Sivram, Chemical Review, 1986, 86, 353).

Metallocene and other single site catalysts are highly selective and result in polymers of very narrow molecular weight distribution (J A Glaysz, Chemical Review, 2000, 100, 1167; H G Alt and A Koppl, Chemical Review, 2000, 100, 1205). During the synthesis of these catalysts, a thick polymer coating is reported to be formed on the polymerisation reactor wall and its stirrer which adversely affects the heat transfer characteristics of the catalytic system (H G Alt, J Chem. Soc., Dalton Trans, 1999, 1703). Besides, unless anchored on a solid support these catalysts cannot be efficiently used in a number of commercial reactors. To overcome the above drawbacks and also in an attempt to produce polymers with a bimodal distribution of molecular weight as is usually desirable in the case of polyethylene catalyst comprising metallocenes or other single site catalysts and/or aluminoxane cocatalysts supported on an inorganic carrier like silica or an organic carrier like resinous polyethylene, polypropylene,

crosslinked copolymer of divinyl benzene, styrene and acetoxy/hydroxy styrene, polyvinyl chloride, polyamide, polycarbonate, acrylonitrile-butadiene-styrene copolymer or polymethylmethacrylate have been developed (US Patents Nos 473268, 4808561, 4921825, 5362824 and 5461017 and G C Hlatky, Chemical Review, 2000, 100, 1347). These developments, however, are limited to metallocene and/or aluminoxane cocatalysts only.

Particle size distribution of a solid catalyst used for polymerisation determines the properties of the resultant polymer. These properties of the polymer in turn determine the throughput in the polymerisation plant as well as the ease with which the polymer is processed. Particle size distribution of a solid catalyst is therefore an important feature. However, in the above mentioned catalysts, one disadvantage is that, only by starting with a support or carrier material of predefined particle size, the particle size of the support catalysts may be controlled.

OBJECTS OF INVENTION:

An object of the invention is to provide an olefin polymerisation titanium catalyst, which shows good activity.

Another object of the invention is to provide an olefin polymerisation titanium catalyst, which is devoid of magnesium support and eliminates drawbacks associated therewith.

Another object of the invention is to provide an olefin polymerisation titanium catalyst, which is simple and easy to make and is economical.

Another object of the invention is to provide a process for the preparation of an olefin polymerisation titanium catalyst which is simple and convenient to carry out besides being economical.

Another object of the invention is to provide a process for the preparation of an olefin polymerisation titanium catalyst, which shows good activity.

Another object of the invention is to provide a process for the preparation of an olefin polymerisation titanium catalyst, which is devoid of magnesium support and eliminates drawbacks associated therewith.

Another object of the invention is to provide a process for the polymerisation of olefin employing the titanium catalyst, which is very efficient.

DESCRIPTION OF INVENTION:

According to the invention there is provided an olefin polymerisation titanium catalyst comprising a titanium compound and an organoaluminium compound cocatalyst supported on a soluble polysulfone comprising free reactive sulfone groups, wherein the molar ratio of titanium to aluminium is 1-10 : 200 and the weight ratio of titanium to

polysulfone is 0.1 - 0.01 : 0.3- 2.5.

According to the invention there is also provided a process for the preparation of an olefin polymerisation titanium catalyst comprising a titanium compound and an organoaluminium compound cocatalyst supported on a soluble polysulfone comprising free reactive sulfone groups, wherein the molar ratio of titanium to aluminium is 1-10 : 200 and the weight ratio of titanium to polysulfone is 0.01-0.1 : 0.3-2.5; the process comprising:

a) preparing a supported titanium compound by contacting a solution of a polysulfone in a halogenated or polar solvent with a titanium compound or a solution thereof in a halogenated or polar solvent in an inert atmosphere at a temperature between 10°C and the boiling point of the solvent, wherein the weight ratio of titanium to polysulfone is 0.01-0.1 : 0.3 - 2.5; and

b) mixing the supported titanium compound with an organoaluminium cocatalyst such that the molar ratio of titanium to aluminium is 1-10 : 200.

The precipitated supported titanium compound is separated or filtered out from the reaction mixture of step (a) prior to mixing with the cocatalyst.

According to the invention there is also provided a process for the polymerisation of an olefin employing a titanium catalyst comprising a titanium compound and an organoaluminium compound cocatalyst supported on a soluble polysulfone comprising free reactive sulfone groups, wherein the molar ratio of titanium to aluminium is 1-10 : 200 and the weight ratio of

titanium to polysulfone is 0.01 - 0.1 : 0.3 - 2.5 the process comprises reacting the olefin with the titanium catalyst under polymerisation conditions in known manner.

The polysulfone support comprising free reactive sulfone groups may be represented by the formula I:

$$X\text{-}(C_6H_4\text{-}4\text{-}SO_2C_6H_4\text{-}4\text{-}O\text{-}C_6H_4\text{-}4\text{-}SO_2\text{-}C_6H_4\text{-}4\text{-}O)_n\text{-}R_1$$

Formula I

wherein n has values 10 - 70, X is halide, R_1 is hydrogen or alkyl group. Preferably n = 25-50, X = Cl and R_1 = H or CH_3 in the formula I.

The olefin may be a lower α-alkene like ethylene, propylene or 1-butene or mixtures thereof, preferably ethylene.

The titanium compound may be titanium tetrahalide, titanium alkoxohalide or titanium tetraalkoxide, preferably titanium tetrachloride and/or titanium tetrabutoxide.

The organoaluminium compound cocatalyst may be trialkyl or oxoalkyl compound like methyl aluminoxane or triethyl aluminum, preferably methyl aluminoxane.

The molar ratio of titanium to aluminium is preferably 10 : 200.

The halogenated solvent may be methylene dichloride or 1,2-dichloroethane preferably methylene dichloride. The polar solvent may be

dimethyl sulfoxide or dimethyl formamide, preferably dimethyl formamide.

The supported titanium compound may be prepared in an inert atmosphere provided by nitrogen or argon, preferably argon and at a temperature of, preferably, 20 - 50°C.

The particle size distribution, degree of titanium incorporation in the catalysts and other physico-chemical properties of the catalyst which determine its performance are controlled by the weight ratio of titanium to polysulfone at the time of contact. Preferably the weight ratio of titanium to polysulfone is 0.04 : 0.3. The mean particle size of the titanium compound catalyst is 10 - 100μ, preferably 15 - 45μ.

The constituents of the polymerisation catalyst may be mixed in a vessel outside the polymerisation reactor and then transferred thereinto. Alternatively they may be mixed together in the reactor to form the catalyst insitu.

The polymerisation of olefins is carried out in known manner using the catalyst of the invention in gas phase employing one or more fluidised beds of the catalyst. Alternatively it may also be conducted in a slurry phase in the presence of an inert hydrocarbon diluent like toluene or hexane.

The reactive free sulfone groups along the catalyst support chemically bond with titanium atoms. Therefore, the titanium atoms are well dispersed and distributed in the catalyst. As a result the catalyst shows high

performance or activity in the polymerisation of olefins. Because catalyst does not comprise any magnesium compound it eliminates the use of excess titanium compound as a halogenating agent in its preparation. Also the preparation of this catalyst does away with special techniques like ball milling, spray drying or melting. Further the invention does away with stringent requirement as regards the selection of predetermined particle size distribution for the support to control the particle size distribution of the catalysts as the same is achieved by selecting the titanium to polysulfone ratio at the time of preparing the titanium compound. Besides, handling of the polysulfone in solution is easy and convenient. The process of the invention is very simple, less time consuming and convenient to carry out for the above reasons. The invention is also economical for the above reasons. Due to the high activity of the catalyst polymerisation efficiency is increased.

The following experimental examples are illustrative of the invention but not limitative of the scope thereof.

Example 1

To a 100 ml methylene dichloride solution of 5g of polysulfone (formula I, wherein X = Cl, $R_1 = CH_3$ and n = 25-50) was added 1.7g of $TiCl_4$ under nitrogen atmosphere and stirred at 25 - 30°C for 2 hrs. The yellow solid formed was filtered out. It showed 2.6% titanium incorporation and a mean particle size of D90 137.8µ. The solid (0.5g) was mixed with 30% methyl aluminoxane (2.2g) to obtain the catalyst (titanium : aluminium : : 1:100).

Example 2

The procedure of Example 1 was followed except that 5g of polysulfone (formula I, wherein X = Cl, R_1 = H and n = 25-50) and 8.7g of $TiCl_4$ were used. The yellow solid (0.5g) formed showed 10.5% titanium incorporation and a mean particle size of D90 48.5μ.

Example 3

To a 100 ml methylene dichloride solution of 5g of polysulfone (formula I, wherein X = Cl, R_1 = H and n = 25-50), was added 1.0g of $Ti(OBu^n)_4$ under nitrogen atmosphere and stirred at 25 - 30°C for 12 hrs. The off-white solid formed was filtered out. It showed 0.2% titanium incorporation and a mean particle size of D90 80.0μ The solid (0.5g) was mixed with 30% methyl aluminoxane (2.1g) to obtain the catalyst (titanium :aluminium : : 1:100).

Example 4

The procedure of Example 3 was followed except that 6.4g of $Ti(OBu^n)_4$ was used. The off-white solid (0.5g) formed showed 0.2% titanium incorporation and a mean particle size of D90 59.9μ.

Example 5

The procedure of Example 3 was followed except that 0.85g of $TiCl_4$ and 0.5g of $Ti(OBu^n)_4$ were used. The solid (0.5g) formed showed 1.5% titanium incorporation and a mean particle size of D90 63.5μ.

Example 6

The procedure of Example 1was followed except that 100ml of dimethyl formamide was used. The yellow solid (0.5g) formed showed 2.7% titanium incorporation and a mean particle size of D90 135.2μ

Examples 7 to 10

The catalysts of Examples 1 to 5 (2.5g) were used in slurry phase polymerisation of ethylene in toluene (200ml) at 1 bar pressure and at 25 - 30°C. The productivities of the polymers were as follows:

Catalyst	Productivities in kg/mol Ti/h
Example 1	50
Example 2	10
Example 3	55
Example 4	40
Example 5	15

The above productivities show the high performance of the catalyst of the invention in the polymerisation of olefins, specially lower α-olefin.